CHAPTER 8

Innovation Policy in Thailand

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8.1 | Introduction

From the 1960s to the mid-1990s, Thailand experienced remarkable success in its economic development, with average gross domestic product (GDP) growth of more than 6% per year. The country has transformed itself from a traditional agrarian economy into a modern one, as reflected by the changes in its labour force composition (Figure 8.1). While the service sector constitutes the largest share of the country's GDP, Thailand's growth has always been driven by the export of manufactured products. With manufacturing value-added contributing 26.9% of its GDP in 2015, Thailand has become a major 'factory of the world', nearly on par with China and the Republic of Korea (henceforth, Korea) (Figure 8.2). The success of Thai manufacturing is due to Thailand's ability to attract foreign direct investment and Thai companies' ability to participate in global value chains, mainly as subcontractors of multinational companies.[1]

Over time, Thailand has also been successful in diversifying its exports in terms of both products and markets (Figure 8.3a). This diversification makes the Thai economy less susceptible to demand shocks in the global economy compared with countries such as Malaysia and Viet Nam, which export fewer product items and concentrate their export markets in fewer countries (Figure 8.3b).

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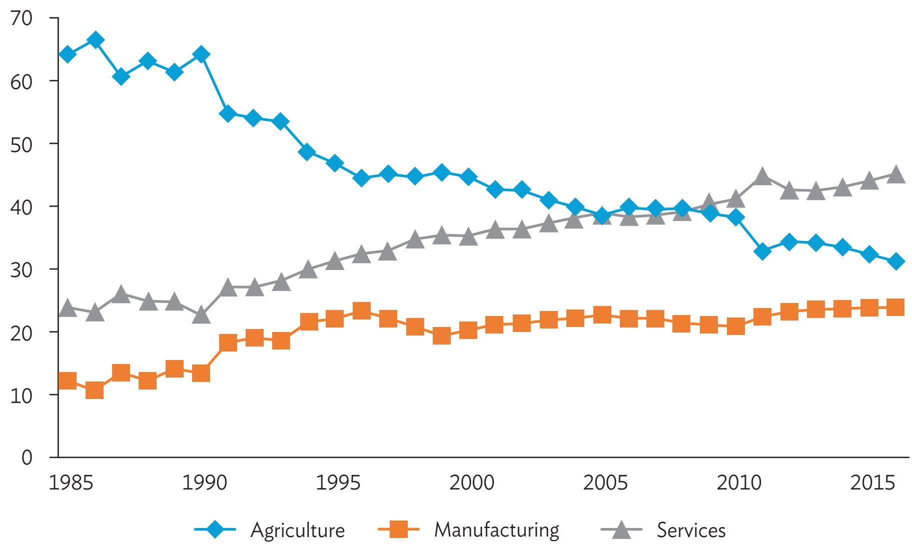
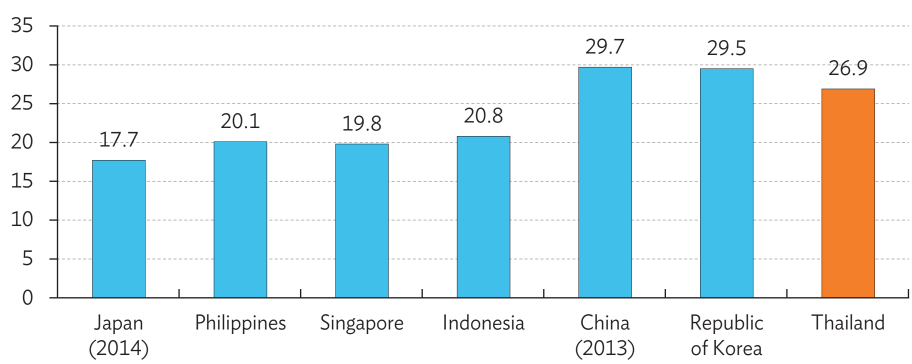
Figure 8.1: Distribution of the Labour Force across Sectors, 1985–2016 (%)



Source: National Statistical Office of Thailand, Labour Force Survey, various years.

Figure 8.2: Manufacturing Value-added Share of Gross Domestic Product, 2015 (%)



Source: World Bank. Databank. Manufacturing, value added (percentage of GDP). http://data.worldbank.org/indicator/NV.IND.MANF.ZS (accessed 10 November 2016).

Most Thai manufacturing companies are original equipment manufacturers (OEMs) that supply parts, components, or finished products to be marketed by multinational companies that own brands. As such, they generally have low profit margins as they face continuous pressure to reduce their prices, improve the quality of their products, and deliver on time. Many have not survived and have had to exit the market.

Figure 8.3a: Diversification of Thailand's Exports and Markets, 2001–2016 (%)

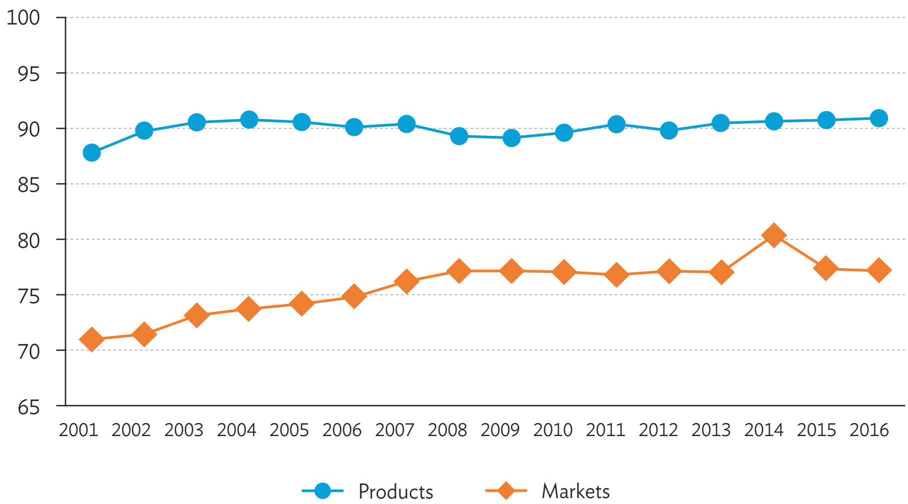
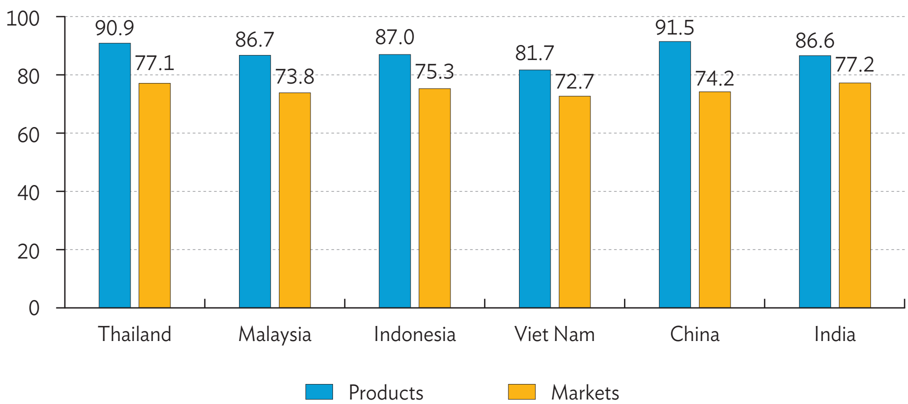


Figure 8.3b: Degree of Export Diversification in Products and Markets, 2016 (%)



Note: The level of diversification of export products is $100x\left(1-\sqrt{\sum_i\left(\frac{X_i}{X}\right)^2}\right)$, with X representing the total value of all exported products and X_i representing the total value for a particular exported product (i). The level of diversification of export markets is defined similarly.

Source: Authors, from UN Comtrade data.

Those that have managed to survive are generally quite efficient as they have adopted 'lean production' techniques pioneered by Japanese automotive assemblers.[2] The techniques are usually spread from Japanese companies investing in Thailand to their suppliers (Suehiro, 2008). Box 8.1 provides a case study on how foreign direct investment has facilitated technology transfer in the automotive and parts industries in Thailand.

While there is still much room for improvement in lean production, especially among small and medium-sized enterprises, large companies have mastered the techniques. Many have also introduced automation and robots into their factories as Thailand is increasingly facing labour shortages. The country imported 2,556 units of industrial robots in 2015 (International Federation of Robotics, 2016).

While Thailand has a relatively high degree of participation in global value chains, its ability to generate domestic value-added is still below average (Figure 8.4). To achieve higher growth rates, the country can no longer rely only on the movement of its labour force from agriculture to manufacturing, further diversification of its exports, and incremental improvement of its production system. As argued by Doner et al. (2005), industrial upgrading must replace diversification for a country to sustain high growth in the long run. Thus, the only way forward is to increase productivity through innovation. In particular, Thai companies must develop design, branding, and marketing capabilities. While innovation usually goes far beyond the confines of research labs to users, suppliers, and other external parties, research and development (R&D) remains a key instrument to absorb, integrate, and create the new knowledge employed in most innovation activities.[3] For Thailand to be innovative, far greater investment in R&D is indispensable.

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2 Under the lean production system, inventory levels were kept at an absolute minimum so that costs could be shaved and quality problems quickly detected and solved; bufferless assembly lines assured continuous flow production; utility workers were conspicuous only in their absence from the payroll. If a worker was absent without notice, the team would fill in; repair areas were tiny as a result of the belief that quality should be achieved within the process, not within a rectification area (Krafcik, 1988).

3 The relationship between R&D and innovation can be highly complex. There are many steps linking R&D to product innovation, process innovation, marketing innovation, and organisational innovation. There are also many feedback loops between these steps. Innovation does not necessarily require progression through all steps in a successive linear fashion as there are multiple entry points to the process (National Science Foundation, 2012).

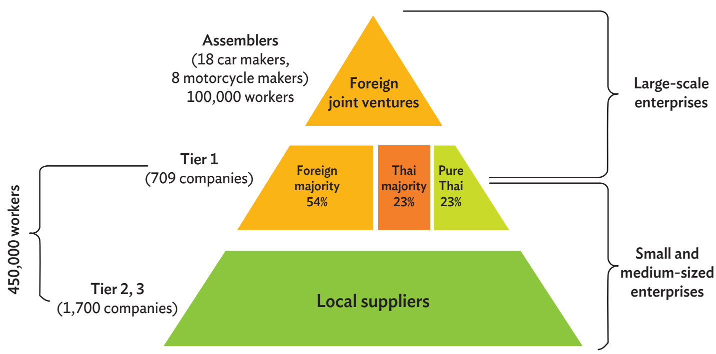
BOX 8.1

FOREIGN DIRECT INVESTMENT AND TECHNOLOGY TRANSFER IN THE THAI AUTOMOTIVE AND PARTS INDUSTRIES

The development of the automotive and parts industries in Thailand has been driven by foreign direct investment by foreign assemblers, especially Japanese carmakers, and their first-tier suppliers. Besides possessing brand and component manufacturer networks, these companies own the technologies to produce key automotive components, such as engines, transmissions systems, and electronic control systems. Major foreign assemblers in Thailand include Toyota Motors, Honda Automobile, Nissan Motors, Mitsubishi Motors, Suzuki Motors, Isuzu, Mazda, General Motors, Ford Motor, BMW Manufacturing, and Tata Motors.

According to the Thai Auto Parts Manufacturers Association, the automotive and auto parts industries in Thailand have 709 tier 1 suppliers, including foreign-majority companies (54%), Thai majority companies (23%), and wholly owned Thai companies (23%) (Figure). There are around 1,700 tier 2 and 3 suppliers, most of which are local suppliers.

Structure of the Thai Automotive Industry

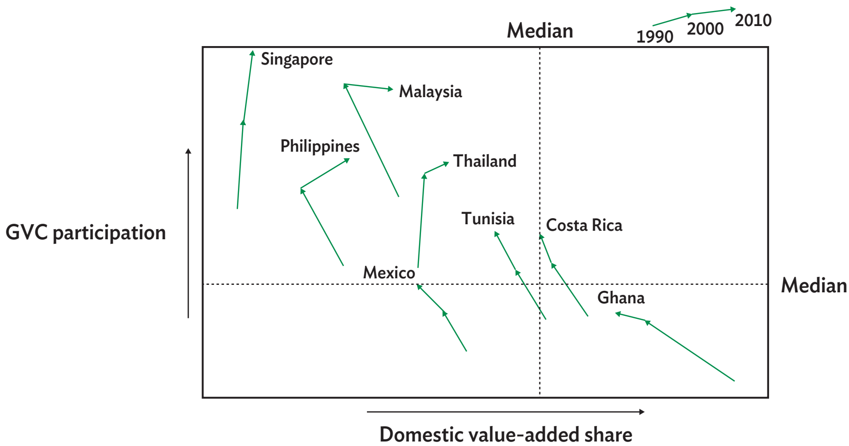


Source: Thai Auto Parts Manufacturers Association (2014), 'Study on the Parts and Components Structure of the Thai Automobile Industry' (in Thai). http://data.thaiauto.or.th/iu3/images/stories/PDF/Research/RD_Supply_Chain.pdf

Local tier 2 and 3 suppliers usually produce unsophisticated parts, such as seats or bodywork for automobiles. They are required to source raw materials and machinery based on the requirements of higher-tier producers. To win more orders, lower-tier suppliers must constantly increase the productivity of their production processes. They must master 'lean production' techniques, such as the Toyota Production System, both from self-learning and through knowledge transfer from the assemblers. Some local suppliers, such as Thai Summit Group, Summit Group, PCS, and Somboon Advance Technology, have mastered the technologies and become tier 1 suppliers.

Working closely with assemblers also allows suppliers to access product technologies. Tier 1 suppliers are being increasingly contracted to conduct research and development, design, and testing in cooperation with the assemblers. Some Thai tier 1 suppliers have set up in-house research and development units. Suppliers that have not been able to upgrade have become replacement equipment manufacturers or traders.

Figure 8.4: Global Value Chain Participation and Domestic Value-added Share of Selected Countries, 1990–2010



GVC = global value chain.

Source: United Nations Conference on Trade and Development (2013).

R&D is increasingly important as Thailand will face many challenges in the near and medium term. The most important challenges will be demographic ones. Under the medium-fertility case, the country is forecast to become an aged society by 2022, with over 14% of its population aged 65 or above, and a hyper-aged society by 2032, with over 21% aged 65 or above (NESDB, 2013). Thailand will age faster than all Asian economies, except Japan, Korea, Hong Kong, Singapore, and Taiwan. However, while these economies have already reached high-income status, Thailand is still a middle-income country. Thailand's population aged 65 or older will equal those aged 15 or below by 2025. China, Viet Nam, and Malaysia are forecasted to reach that stage in 2030, 2040, and 2050, respectively, whereas Indonesia and the Philippines will not have reached that stage by 2050, almost three decades after Thailand (Magnus, 2014).

As Thailand's birth rate declines, its population is projected to decrease to about 63.8 million by 2045,[4] a situation which is likely to create a severe shortage of labour. The Thai labour supply already began to decline in 2016, and the country has reached its 'Lewis turning point' – a point at which there is almost no surplus rural labour to move into the manufacturing or service sectors. This, in turn, typically causes urban

4 In 2016, the population in Thailand was 68.86 million (World Bank Database).

wages to rise dramatically. A study by the Asian Development Bank (2016) points out that Thailand has suffered a significant decline in its potential output growth rate, which is now one of the lowest in Southeast Asia. Thailand's annual potential output growth declined by 0.9% between 2000–2007 and 2008–2013 (Table 8.1), mainly due to the decline in labour force growth.

Table 8.1: Change in Potential Output Growth and Its Components between 2000–2007 and 2008–2013 (%)

	Annual Potential Output growth	Trend Labour Force Growth	Potential Labour Productivity Growth
China	–1.0	–1.3	0.3
India	0.1	–0.3	0.4
Indonesia	1.0	0.0	1.0
Japan	–1.4	–0.5	–0.9
Malaysia	–0.4	–0.5	0.1
Philippines	0.3	–0.2	0.5
Singapore	–0.3	0.8	–1.1
Republic of Korea	–2.1	0.2	–2.3
Thailand	**–0.9**	**–0.6**	**–0.3**
Viet Nam	–1.4	–0.8	–0.6
Cambodia	–1.8	–0.7	–1.1

Source: Asian Development Bank (2016).

In addition, as Thailand rapidly becomes an aged society, its social security fund is expected to become insolvent by around 2045. This can only be prevented if the fund is drastically reformed in time. The huge fiscal burden will also increase as the cost of healthcare rises while the number of people paying taxes shrinks.

In conclusion, Thailand will face various challenges as the country becomes an aged society. This will have negative impacts on all Thai people. Thus, the country must develop its economy and avoid the 'middle-income trap'[5] within the next decade,

5 The middle-income trap can be described as a trap of policy misdiagnosis when countries fail to match their growth strategies with the prevailing structural characteristics of their economies. Middle-income countries can fall into two types of common traps. One is sustaining labour-intensive manufacturing export-led growth despite the competitive disadvantage caused by higher wages. Another is trying to leapfrog prematurely into 'knowledge economies', with none of the institutional infrastructure in place to accomplish this (Gill and Kharas, 2015).

or Thai people will grow old before the country becomes affluent enough to build an adequate social safety net to accommodate these issues. It is widely believed that Thailand will fall into the middle-income trap and will be unable to escape it in the near future. This is because the country has industrialised without developing its own technological capabilities. Instead, it emphasises exporting by suppressing labour wages to be competitive in the global market. This development model means that the population has both low income and low purchasing power. Consequently, income distribution is highly uneven. Finally, the current development model is also not environmentally friendly as businesses prefer to suppress production costs as much as possible rather than protect the environment.

In summary, Thailand may have successfully shifted from a development model centred on exploiting natural resources to transition towards a model built upon efficiency. However, Thailand will soon have to concentrate on developing an economy based on knowledge creation and innovation if it wants to become a high-income country.

The following sections will analyse the current state of innovation in Thailand, discuss the country's innovation policies, and provide policy recommendations on how to encourage more innovation in Thailand.

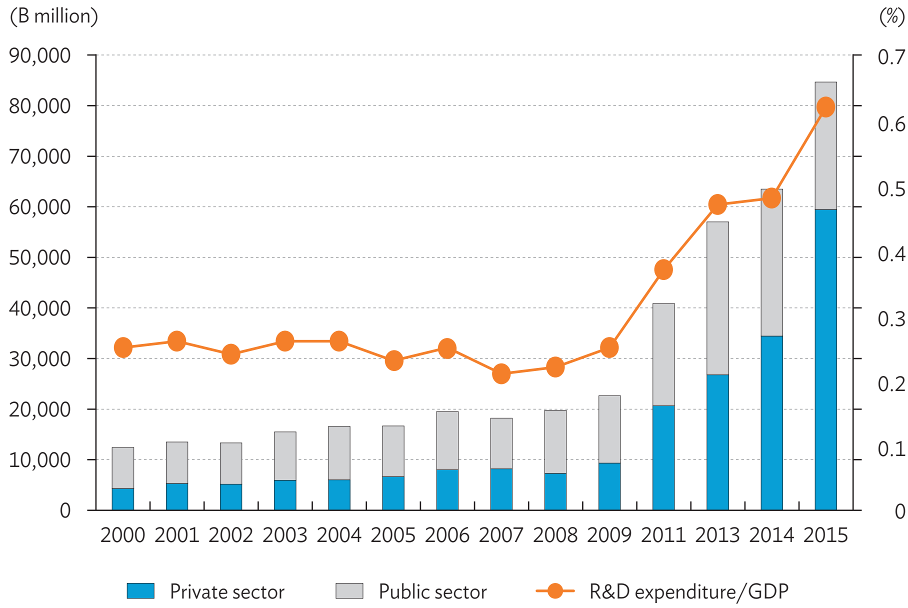
8.2 | State of Innovation in Thailand

In this section, we briefly discuss the state of innovation in Thailand by first analysing two major inputs to the R&D system: the R&D investment budget and R&D human resources. We then discuss the outputs derived from these inputs and assess the efficiency of the Thai R&D system. Finally, we provide examples of local companies that are engaged in R&D and innovation and the benefits of such activities.

8.2.1 Research and development inputs

Investment in R&D is an important input for creating technological innovation. Although Thailand's R&D investment has gradually increased, it remains very small, at around 0.62% of GDP in 2015 (Figure 8.5). This is far below the levels of advanced economies in Asia, such as Korea (4%), Japan (3.6%), Taiwan (2.9%), and Singapore (2.3%). Nonetheless, a positive sign is that private R&D investment is rising quickly and has surpassed public investment since 2011.

Figure 8.5: Research and Development Investment in Thailand, 2000–2015



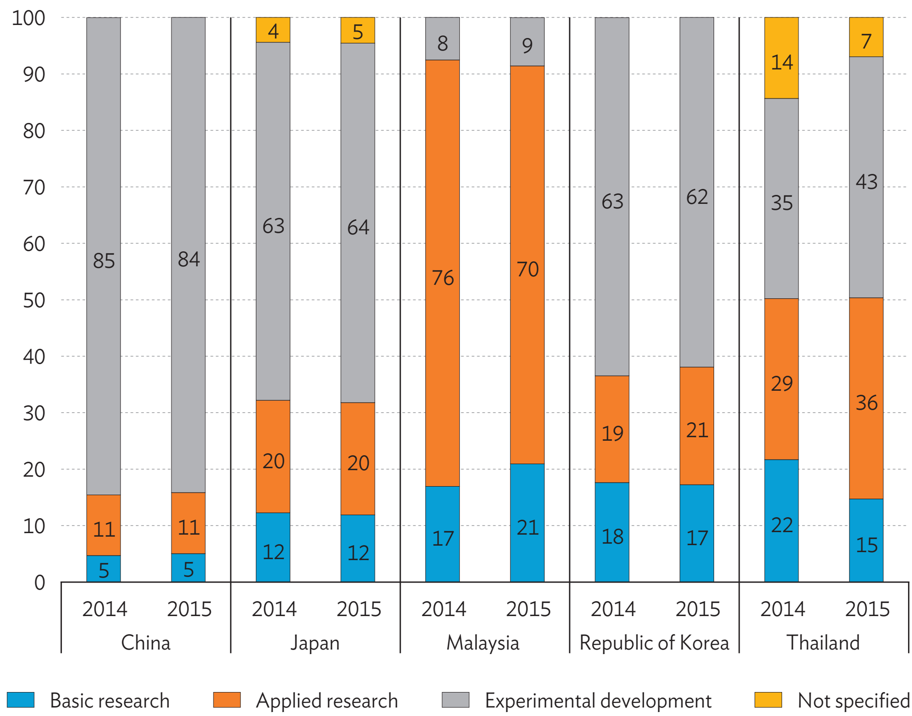
GDP = gross domestic product, R&D = research and development.

Source: National Research Council and National Science Technology and Innovation Policy Office.

There are at least three types of R&D activities: basic research, applied research, and experimental development (OECD, 2015).[6] Compared with other countries, Thailand invests a higher portion of its research budget in basic research (Figure 8.6). Such research is sometimes called frontier research, fundamental research, or blue skies research. The outcome of basic research is inherently unpredictable and generally cannot be applied to real-world problems, at least in the short term. While most developed countries can strongly commit to undertaking basic research, it is probably unwise for Thailand to invest so heavily in basic research as it is still a developing country.

[6] Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken to acquire new knowledge, but it is directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed at producing new materials, products, or devices; installing new processes, systems, and services; or improving substantially those already produced or installed (OECD, 2015).

Figure 8.6: Composition of Research Investments, Classified by Type of Research, 2014–2015 (%)



Sources: United Nations Educational, Scientific and Cultural Organization and National Research Council (accessed 15 January 2018).

Another important input to the R&D system is R&D personnel. The full-time equivalent number of Thai R&D personnel almost tripled from 32,011 in 2001 to 89,617 in 2015, accounting for a compound annual growth rate of 8% (Table 8.2). The ratio of private sector R&D personnel to the total R&D personnel also rose significantly from 30% to 55% in the same period. As nearly half of all R&D personnel are employed in the public sector – especially in public universities, government research institutes, and other public agencies – the private sector is experiencing a shortage of R&D personnel as it tries to continue to increase its R&D investment.

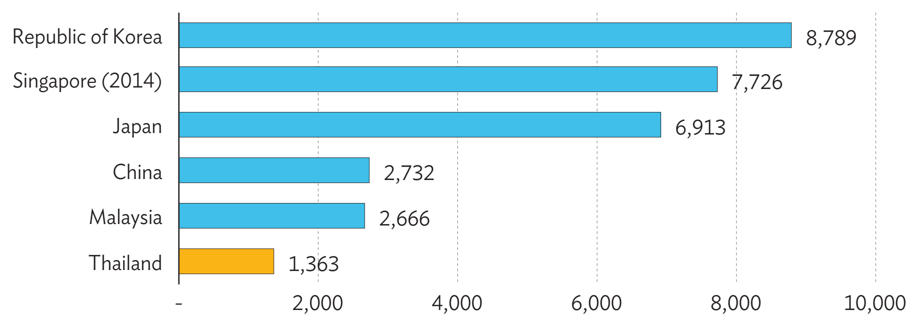
Despite the rapid increase, the number of R&D personnel per million population is still considered very small by regional standards. At about 1,363 per million population in 2015, the ratio is significantly lower than that of Malaysia (2,666), China (2,732), Japan (6,913), Singapore (7,726), and Korea (8,789) (Figure 8.7).

Table 8.2: Thai Research and Development Personnel, 2001–2015 (full-time equivalent)

Year	Number (persons)			Ratio (%)		Number per Million Population
	Private	Public	Total	Private	Public	
2001	9,710	22,301	**32,011**	30.3	69.7	514
2003	7,010	35,369	**42,379**	16.5	83.5	672
2005	7,750	29,217	**36,967**	21.0	79.0	592
2007	8,645	33,979	**42,624**	20.3	79.7	676
2009	11,846	48,496	**60,342**	19.6	80.4	950
2011	22,245	30,877	**53,122**	41.9	58.1	829
2013	25,513	45,173	**70,686**	36.1	63.9	1,091
2014	39,043	45,173	**84,216**	46.4	53.6	1,293
2015	49,004	40,613	**89,617**	54.7	45.3	1,363

Sources: National Research Council and National Science Technology and Innovation Policy Office.

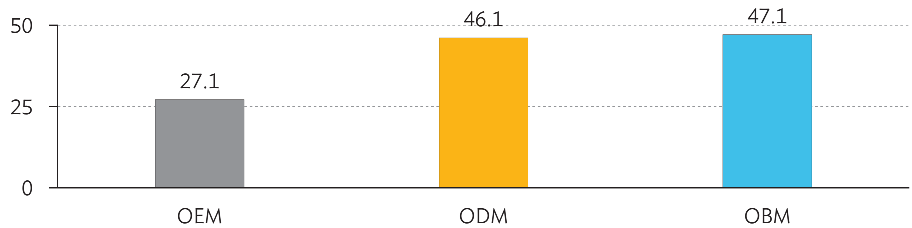
Figure 8.7: Research and Development Personnel, 2015 (number per million population)



Sources: United Nations Educational, Scientific and Cultural Organization and National Science Technology and Innovation Policy Office.

To understand R&D activities among Thai firms, we turn to the Research, Development and Innovation Survey conducted by the National Science, Technology and Innovation (NSTI) Policy Office. According to the survey, Thai manufacturers engaged in R&D activities were still in the minority in 2014, accounting for only 36.2% of total Thai manufacturing firms. Firms engaged in R&D comprised 27.1% of OEMs, 46.1% of original design manufacturers (ODMs), and 47.1% of original brand manufacturers (OBMs) (Figure 8.8).

Figure 8.8: Share of Firms Engaged in Research and Development, Classified by Firm Type, 2014 (%)



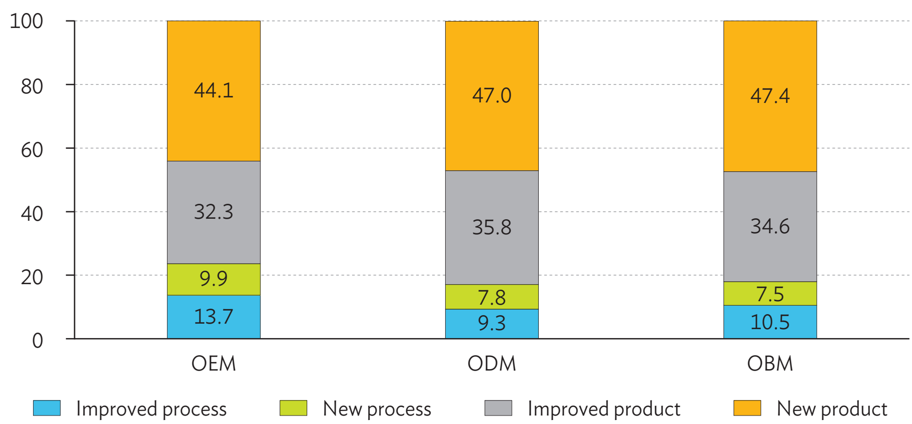
OBM = original brand manufacturers, ODM = original design manufacturers, OEM = original equipment manufacturers.

Note: Here, OEMs are defined as firms with at least 50% revenue from manufacturing products without their own design or own brand. ODMs are those with at least 50% revenue from manufacturing products with their own design. OBMs are those with at least 50% revenue from manufacturing products with their own brand.

Source: Authors, from the National Science, Technology and Innovation Policy Office's Research, Development and Innovation Survey data.

The survey also shows that all firm types conducted R&D to improve their products more than to improve their production processes (Figure 8.9). However, OEMs tended to invest in R&D to improve their production processes more than OBMs and ODMs.

Figure 8.9: Objectives of Research and Development among Firms, 2014 (%)



OBM = original brand manufacturer, ODM = original design manufacturer, OEM = original equipment manufacturer.

Note: Here, OEMs are defined as firms with at least 50% revenue from manufacturing products without their own design or own brand. ODMs are those with at least 50% revenue from manufacturing products with their own design. OBMs are those with at least 50% revenue from manufacturing products with their own brand.

Source: Authors, from the National Science, Technology and Innovation Policy Office's Research, Development and Innovation Survey data.

8.2.2 Research and development outputs and efficiency

At the aggregate level, given its much smaller inputs, it is not surprising that the Thai R&D system produces smaller outputs. Here we are interested in outputs that are related to commercial applications, which can be proxied by the number of patents.[7] As shown in Table 8.3, the number of resident applications for patent from Thailand was about 15 per million population in 2014, which was considerably lower than those of Malaysia (45), Singapore (238), and China (587).

Table 8.3: Resident Applications for Patent by Origin, 2010–2015 (number per million population)

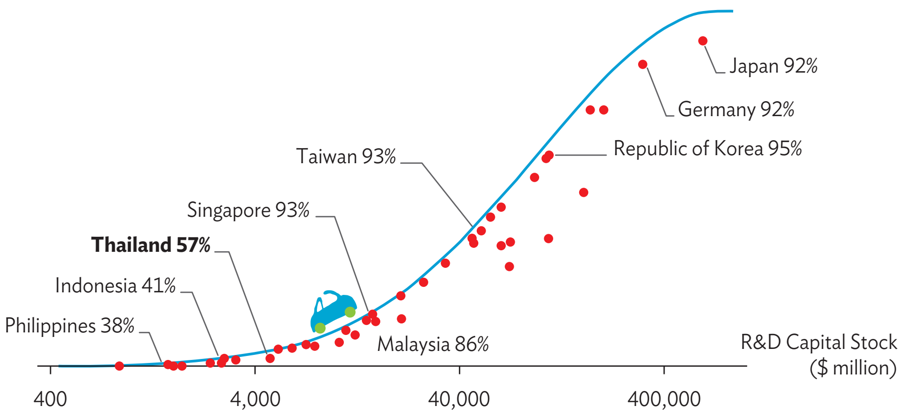
Country	2010	2011	2012	2013	2014	2015
Japan	2,265	2,250	2,250	2,134	2,092	2,039
Republic of Korea	2,668	2,773	2,962	3,186	3,254	3,305
United States	782	795	856	910	894	897
Germany	910	895	919	900	912	887
China	219	309	396	519	587	706
Singapore	176	204	203	212	238	265
Malaysia	44	38	38	41	45	42
Thailand	**18**	**14**	**15**	**23**	**15**	

Source: World Intellectual Property Organization Statistics Database.

However, Thailand's smaller R&D outputs were also due to its lower R&D efficiency. Based on a stochastic frontier analysis of input–output data during 2002–2010, Tangkitvanich, Rattanakhamfu, and Rakkiatwong (2013) found that the efficiency of the Thai R&D system was only 57% of the maximum obtainable output given the levels of input (Figure 8.10). The Thai efficiency rate was also considerably lower than the rates for Malaysia (86%), Japan (92%), Singapore (93%), Taiwan (93%), and Korea (95%).

7 Patent ownership is neither necessary nor sufficient for the commercialisation of R&D because only a small proportion of patents can be used for commercialisation. Many patents are also filed for 'defensive' and other purposes. In some cases, companies resort to using trade secrets, rather than patents, to protect their innovations. Still, patents are widely used as proxies for commercial innovation as the data on patents are publicly available.

Figure 8.10: Comparing Efficiencies of Research and Development Systems



Source: Tangkitvanich, Rattanakhamfu, and Rakkiatwong (2013).

Thailand's low R&D efficiency can be attributed to at least three main reasons. First, the system remains largely supply driven as a result of the relatively low private R&D investment share. In a supply-driven setting, publicly funded R&D projects are set up based on the academic interests of the researchers involved rather than on the demands of the economy and society. Many of these research projects are basic in nature and are intended for journal publications. As a result, the research outputs tend to have little application value, at least in the short term. This is reflected in the small number of licensing agreements between Thai research universities and the private sector, and the modest amount of licensing revenue (Table 8.4).

Second, it is difficult to hold universities and government research institutes accountable as they usually have multiple mandates. For example, Thai research universities have mandates not only to conduct research but also to educate a large number of undergraduate students and to provide community services. There are some cases of successful university–industry collaboration in Thailand, such as those between Betagro and King Mongkut University of Technology Thonburi, Thai Union Frozen Products and Mahidol University, and Lion Corporation (Thailand) and Chulalongkorn University (Table 8.5). However, these are still exceptions rather than normal practices, and their overall impact remains small.

Government research institutes have more research time, human capital, and research facilities than their private counterparts. Thus, they are expected to play important roles in promoting the diffusion and use of new and existing knowledge in the economy.

Table 8.4: Licensing Agreements and Licensing Revenue of Research Universities in Thailand

Item	CU	MU	KU	KK	CMU	SUT	PSU	KMUTT
Year of establishment of TLO	1995	1998	1996	2006	2007	2007	2007	1995
Number of staff engaged in licensing and related activities	4	n/a	n/a	2	2.5	2	2.5	2
Number of staff engaged in patent filing and related activities	6	n/a	6	4	4.5	6	4	n/a
Licensing agreements (2008–2011)	42	n/a	19	n/a	n/a	10	n/a	n/a
Revenue from licensing out (B million) (2008–2011)	19.5	n/a	10.4	1.7	5.9	3.2	0.9	1.2
Number of invention disclosures	51	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Local utility patents 2011–2012 (applied/granted)	44/1	0/2	12/0	14/0	n/a	17/0	21/0	14/0
Cumulative local utility patents (applied/granted)	n/a	(n/a)/34	209/28	71/4	(n/a)/67	96/4	(n/a)/51	162/14

n/a = not available, CMU = Chiang Mai University, CU = Chulalongkorn University, KK = Khon Kaen University, KMUTT = King Mongkut University of Technology Thonburi, KU = Kasetsart University, MU = Mahidol University, PSU = Prince Songkla University, SUT = Suranaree University of Technology, TLO = Technology Licensing Office.

Source: United Nations Conference on Trade and Development (2016).

They can also perform a bridging role that links research activities with those producing products (Intarakumnerd, 2014). However, this expectation has not been fulfilled in the case of Thailand. For example, the National Science and Technology Development Agency (NSTDA) – the organisation that has been allocated the largest budget and has the largest number of talented researchers – has a broad set of legally mandated missions, including policy studies; R&D; product quality testing and calibration; reviewing and assessing imported technologies; developing basic R&D infrastructure; and developing R&D human resources. It is also unclear how the NSTDA should prioritise its work to respond to the potentially competing demands from the commercial and social sectors. Moreover, the NSTDA is run by scientists with limited industrial experience (Intarakumnerd, 2014). As a result, R&D conducted by the NSTDA has largely yielded prototypes that could not be scaled up for commercial application.

Table 8.5: Examples of University–Industry Collaboration

Private Business and University (source)	Nature of Collaboration
Betagro and King Mongkut University of Technology Thonburi (KMUTT) (Pittayasophon and Intarakumnerd, 2015)	The Betagro Group was founded in 1967 to produce and distribute animal feed. Initially, Betagro and KMUTT jointly initiated the Food Engineering Practice School Program master's degree in 2006, aimed at training students to solve problems in real situations before pursuing their research work. From 2006 to 2015, KMUTT sent about six master's students to Betagro every semester. Betagro proposed several research topics and assigned staff members to be co-supervisors. Each semester, students presented to executives of both parties.
Lion Corporation and Chulalongkorn University (Junhasavasdikul, 2010)	Lion Corporation was established in 1967 to produce powder detergent and shampoo in Thailand to substitute Japanese imports. The university research team discovered a method of generating Silver Nano from silver nitrate, which could stop the growth of bio-organisms in wet conditions and could be applied in a detergent. The joint research team then developed low-cost silver raw materials that could substitute imports and applied for an invention patent. The new product, Pao Silver Nano, was brought to the market.
Thai Union Frozen Products (TUF) and Mahidol University (Ono, 2014)	TUF was founded in 1977 as a canned-tuna processor and exporter. It has grown organically and through mergers and acquisitions to become the world's largest canned-tuna producer. It already has research and development centres near its production facilities that develop products with better taste and packaging. In 2014, TUF and Mahidol University's Faculty of Science jointly set up a $3.3 million research and development centre at Mahidol campus. The new centre focuses on longer-term research. In particular, it conducts research on consumption patterns, tuna processing technology, tuna nutrition and varieties, and using all fish parts for additional revenue.

Sources: Pittayasophon and Intarakumnerd (2015); Junhasavasdikul (2010); Ono (2014).

Third, the private sector lacks the sufficient human resources to expand its R&D activities, even if it were willing to invest more. This is because most researchers are employed by public universities, government research institutes, and government agencies. According to the NSTI Policy Office's 2015 survey, 54.7% of R&D personnel are employed by the public sector, while only 45.3% are employed by the private sector. As these public agencies are almost fully funded by the public budget, they lack an incentive to respond to the needs of the private sector. Intarakumnerd and Charoenporn (2013) argue that government research institutes and public universities in Thailand have not provided much assistance to local companies to enhance their technological capabilities.

With smaller inputs and lower R&D efficiency, Thailand will not be able to catch up with advanced East Asian economies and it risks falling into the middle-income trap. Thus, there is an urgent need for the country to encourage more R&D investment and improve the efficiency of its R&D and innovation system by implementing better policies.

8.2.3 Local companies active in innovation

As Thailand's growth has slowed and it is facing greater resource constraints, an increasing number of Thai companies have recognised the challenges and have begun to be proactive. Many are now conducting R&D and other innovation activities, as shown in Table 8.6.

Table 8.6: Examples of Thai Companies Active in Research and Development and Innovation

Company	Activities	Benefits of Innovation
Siam Cement Group (SCG) is a leading business conglomerate in Thailand. Founded in 1913 to produce cement, the main building material for infrastructure projects, SCG has grown continually. It has three core business units: cement-building materials, chemicals, and packaging. After restructuring and recovering from the Asian financial crisis in 1997, SCG entered a new phase of investing in research and development (R&D) to create a competitive edge. It has also expanded overseas, especially in Association of Southeast Asian Nations Member States.	R&D, design, manufacturing, distribution, marketing, branding	The profit margins of its R&D-based products are 10%–20% higher than those of non-R&D products.
Saijo Denki is a local air-conditioner manufacturer founded in 1987 as an original equipment manufacturer. With R&D capabilities, it has transformed itself into an original brand manufacturer and can compete with foreign air-conditioner manufacturers in Thailand. It exports its products to many countries.	R&D, design, manufacturing, distribution, marketing, branding	Its own-brand products have profit margins 24% higher than original equipment manufacturers.
Silicon Craft was established in 2002 by Silicon Valley veterans who had returned to Thailand. It is Thailand's first and only integrated circuit design company. It designs customised and standard microchips for radio frequency identification applications and delivers products with high-value-added features. Its products are exported to Australia, Canada, China, Europe, the Republic of Korea, New Zealand, and the United States.	R&D, design	Its radio frequency identification products can compete with those of Texas Instruments.
Siam Bioscience was founded in 2009 by CPB Equity, an investment arm of the Crown Property Bureau that manages royal assets. It is Thailand's first and only producer of biosimilar drugs, which are almost identical to original biologic drugs for which patents have expired. An example is biosimilar erythropoietin, which controls red blood cell production for patients with kidney problems.	R&D, design, manufacturing, distribution, marketing, branding	Market entry of the company helped reduce the price of erythropoietin significantly.
PCS is a leading local auto parts manufacturer, specialising in high-accuracy machine parts, i.e. engine, common rails, and transmission parts. It supplies leading Japanese car assemblers in Thailand.	R&D, design, manufacturing	Its common rail parts are competitive in the global market.
Cho Thavee specialises in designing and manufacturing commercial automotive vehicles, such as trucks, trailers, buses, catering trucks, fire rescue vehicles, armoured vehicles, troop carriers, and battle ships.	R&D, design, manufacturing	The company has the largest market share of catering high loader trucks for Airbus 380 worldwide.

Source: Authors' interviews.

8.3 | Innovation Governance and Policies in Thailand

In this section, we begin by briefly analysing the governance structure of the current innovation system. We then discuss the targets set by the government and the policy measures used to achieve them, and evaluate their effectiveness.

8.3.1 Governance structure of the innovation system

The institutional structure in which the Thai R&D and innovation policy system operates is fragmented and fraught with governance issues. The review team of the United Nations Conference on Trade and Development (UNCTAD) identified six major governance issues (UNCTAD, 2016):

(i) **The absence of a strategic driver of policy.** The lack of a strategic policy driver was partly due to the ineffective functioning of the NSTI Policy Committee and the National Research Council – the twin policymaking bodies. By law, both were chaired by the prime minister. However, since the prime minister rarely chaired the meetings, they were chaired by a deputy prime minister or a junior minister, which undermined the sense of ownership among other ministers. This was highly undesirable given the cross-departmental nature of R&D and innovation policies.

(ii) **Several bodies responsible for funding and management.** More problematic from a governance perspective was that some agencies, such as the National Research Council, combined functions of policy guidance and funding of research. This leads to potential conflicts of interest.

(iii) **Insufficient monitoring and evaluation.** The process of budget allocations lacked sufficient monitoring, control, and programme evaluation.

(iv) **Lack of prioritisation.** There was a tendency to elaborate plans consisting of extensive lists of actions, without prioritising them.

(v) **Little private sector involvement.** The private sector was not sufficiently involved or consulted in the policy elaboration process or in making strategic decisions.

(vi) **A confusing system.** A proliferation of government bodies and entry points in the innovation system created confusion, opacity, and misunderstanding among stakeholders. This made it hard for the private sector, particularly small and medium-sized enterprises with limited resources, to understand and navigate the system.

To solve the first two problems, the government reformed the structure of the innovation system in late 2016 by setting up the National Research and Innovation Policy Council as the sole policymaking body. The new body is chaired by the prime minister and served by the joint secretariats of the NSTI Policy Office and the National Research Council Office.[8] Also, under this new structure, the National Research Council no longer functions as a funding agency, resolving its potential conflicts of interest. The remaining problems are to be addressed by the newly formed National Research and Innovation Policy Council.

8.3.2 R&D targets and policy measures

Under the 12th National Economic and Social Development Plan, the Government of Thailand targets economic growth of at least 5% per year during 2017–2021 to increase the country's GDP per capita to US$9,325 (National Economic and Social Development Board, 2017). Annual productivity growth must exceed 2.5% to achieve these targets. The government realises that R&D is important to future growth and has set a target to increase total R&D investment to 2% of the country's GDP and increase the share of private R&D investment to 70% by 2021. It also targets having at least 2,500 R&D personnel per million population by 2021 – almost double the number in 2015.

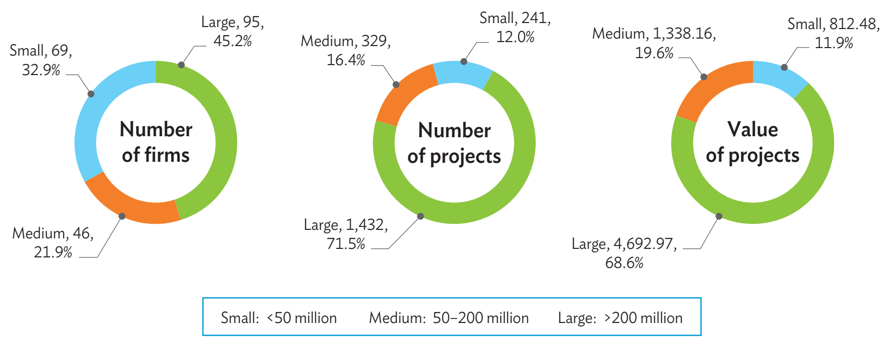
The government employs several policy measures to achieve the R&D investment target. To increase public investment, higher R&D budgets have been allocated to agencies in the line ministries, public universities, research-granting agencies, and government research institutes. The government has also ordered state-owned enterprises to invest at least 1% of their revenue in R&D. It also grants tax incentives to encourage private R&D investment. There are some policy instruments that are rarely used. For example, until very recently, government procurement had never been used to promote technology development, even though it was widely believed to be an effective means for technology transfer in mega-infrastructure projects, such as railways.

Tax incentives have often been used by the government to increase private R&D investment. This is because, unlike direct budget allocation, tax incentives are invisible government spending. An important tax incentive scheme administered by the Ministry of Science and Technology (MOST) allowed a 200% tax deduction for private R&D investment expenditure. The rate was adjusted to 300% after the corporate income tax rate was reduced from 30% to 20% in 2015 to keep the government's subsidy constant at 60%. Previously, the Revenue Department, whose main mission is to collect tax, was responsible for approving R&D investment projects applying for tax deductions. The role was transferred to the NSTDA to facilitate more objective assessment and approval.

8 This is done by the National Council for Peace and Order's Order 62/2559, which has a binding power similar to a legislative act.

The R&D tax incentive appeared to have limited effects on promoting private R&D investment. During 2002–2012 – the latest period for which data are available – the total R&D investment approved for tax deduction was estimated to be B6.85 billion (Figure 8.11). Up to 210 companies were approved for tax deduction in any given year, most of them large. Tax revenue foregone was estimated to be B1.7 billion (US$50 million) during the 11-year period. This is a very small sum compared to tax revenue foregone in other government schemes. For example, the investment tax incentives granted by the Board of Investment (BOI) incurred B278 billion in foregone tax revenue in 2012 alone. It was also small compared to the B92 billion of excise tax revenue foregone incurred by the 'First Car Scheme', which promoted private car ownership during 2012–2013.

Figure 8.11: Use of Tax Deduction for Research and Development, 2002–2012



Source: National Science and Technology Development Agency.

The R&D tax incentive scheme also has many drawbacks. First, it has a 9–12 month approval process. Second, it unintentionally favours larger companies over smaller ones because they can better tolerate the high fixed costs of the application process. In addition, they do not suffer from liquidity problems during the long approval period. Third, the definition of R&D investment is too narrow. In particular, costs related to design and development for commercial uses are ineligible for tax deduction. Moreover, certain expenditures, such as administrative costs, including those related to managing intellectual property, are not deductible under the scheme.

Another important tax incentive scheme to promote R&D and investment in innovation is administered by the BOI. Previously, the BOI focused on attracting large foreign investment projects and paid little attention to technology development.

However, given the need for Thailand to transform itself into a more technologically advanced country, the agency has introduced several new promotional schemes.

First, the BOI revamped its basic investment promotion scheme in 2015. Previously, the level of incentive depended on the sector and location of the investing companies. The new scheme not only revises the list of promoted sectors but also favours activities that generate high value-added. For example, it grants the maximum of eight years of corporate income tax exemption to projects with creative and engineering design, R&D, embedded software development, or cloud services provision.

Second, the new scheme introduces merit-based incentives on top of the basic incentives to stimulate investment activities that benefit the country or the industry at large. Activities eligible for merit-based incentives include R&D carried out in Thailand or jointly with overseas institutes, donation to the Technology and Human Resource Development Fund or approved institutes, acquisition of intellectual property, advanced technology training, development of local Thai suppliers, and product and packaging design. Projects with such activities are entitled to up to three more years of additional tax exemption.[9] For companies that conduct R&D and other innovative activities, the new scheme is far more generous than the previous one. However, it still has the inherent weakness of favouring larger companies over smaller ones due to the reasons specified above. As the BOI has not disclosed data on applications and approvals under the new investment promotion scheme, its adoption, effectiveness, and impacts cannot be evaluated.

To achieve the R&D personnel target, the government is focusing on increasing the number of science, technology, engineering, and mathematics (STEM) postgraduates. Government scholarships are granted to talented students on the condition that they work in the public sector after graduation. At least five government agencies are involved in granting STEM scholarships: the Thailand Research Fund, the MOST, the Institute for the Promotion of Teaching Science and Technology, the Office of the Higher Education Commission, and the Office of the Civil Service Commission. Box 8.2 provides details of some of their programmes.

The UNCTAD review team observed that the Government of Thailand provides only a limited number of scholarships in relation to the size of its student population – fewer than 700 scholarships per year for more than 1.8 million students enrolled

9 For more details, see Thailand Board of Investment. Merit-Based Incentives. http://www.boi.go.th/index.php?page=Merit-based_Incentives.

in undergraduate, master's, or doctorate programmes (UNCTAD, 2016). However, the Thailand Development Research Institute (2016) found that many scholarship programmes were poorly planned or managed. As a result, there were many dropouts, late graduates, and graduates who could not find public agencies to affiliate with. There were also large mismatches between the expertise of the graduates and the demand of the affiliated agencies, and little coordination among the agencies involved, resulting in overlapping missions and rivalry. Therefore, government scholarship programmes should be expanded only when they are properly managed.

BOX 8.2

SELECTED SCHOLARSHIP SCHEMES PROVIDED BY THAI GOVERNMENT AGENCIES

Development and Promotion of Science and Technology Talents Project. The programme is managed by the Institute for the Promotion of Teaching Science and Technology. It has provided scholarships to talented students in science and technology since 1984. The institute collaborates with 10 schools, pairing each one with a mentor university. Each year, the programme offers 100 scholarships at the secondary-education level and 180 at higher levels. During 1984–2013, it granted 4,488 scholarships.

Ministry of Science and Technology Scholarship Program. The programme has granted scholarships to students (high school level to doctorate), civil servants, and university faculty members since 1990. During 1990–2015, it granted 3,712 scholarships for studying abroad and 469 scholarships for studying in Thailand. By 2015, 2,803 persons had graduated from the programme and more than 95% were working in universities and government agencies.

Royal Golden Jubilee PhD Programme. The programme, an initiative of the Thailand Research Fund, provides 300 fellowships annually for doctoral students to conduct research, including one year of study abroad with foreign co-advisers. During 1998–2008, it granted 4,208 scholarships to Thai students and 2,686 PhD students graduated from the programme. The programme has involved more than 1,400 Thai advisers and more than 2,300 international co-advisers in 40 different countries. Its new International Research Network supports researchers and networks formed around research topics of interest to Thailand.

Sources: United Nations Conference on Trade and Development (2016); Thailand Development Research Institute (2016).

Recognising the gap between the demand and supply of research personnel in the public and the private sectors, the MOST launched a programme called 'Talent Mobility' in 2015. The programme aims to encourage the use of new technologies in the private sector by facilitating the mobility of researchers from universities and government research institutes to the private sector. The NSTI Policy Office, which administers the programme, set a target to mobilise at least 200 researchers per year from 15 institutions to spend 20% of their time in the private sector for up to two years. However, the mobility rate is limited as universities and government research institutes have no incentive to participate in the programme (UNCTAD, 2016).

One R&D and innovation personnel policy area that has been overlooked by the Government of Thailand is that of importing foreign human resources. According to the Ministry of Labour, there were about 2.98 million registered migrant workers in Thailand in 2015. However, 95% of them are low-skilled workers from neighbouring countries. Only 5% are high-skilled personnel that work as managers, professionals, technicians, or other skilled workers, either under the cumbersome temporary work permits or under approval by the BOI in promoted companies. This is because, under the Thai labour and immigration law, foreign skilled workers are only permitted to work in a Thai company if it employs four Thai nationals for every employed foreigner and pays a B2 million registration fee for each foreign worker.

8.3.3 Other schemes to promote innovation activities

Many Thai government agencies also operate various schemes to promote innovation activities, in addition to R&D support. Table 8.7 gives some examples of active schemes.

Table 8.7: Schemes to Promote Innovation Activities Other than Research and Development

Organisation	Schemes to Promote Innovation Activities
National Innovation Agency	The National Innovation Agency provides grants to support the development and commercialisation of new products and processes. It also operates the Innovation Coupon Program, which gives potential innovators vouchers for research and technological services to be performed by universities and government laboratories.
National Science and Technology Development Agency (NSTDA)	The NSTDA operates the Industrial Technology Assistance Program to assist companies in technology development projects by connecting them to technology sources, including those from overseas. The programme also supports research and development (R&D), organises training, and funds projects on a 50:50 matching basis. The NSTDA also operates the Thailand Science Park, which hosts its four national research centres specialising in biotechnology, electronics, material sciences, and nanotechnology. Some tenant companies conduct R&D activities in fields related to the activities of the NSTDA's research centres.
Board of Investment	The Board of Investment offers foreign and domestic industrial investors tax incentives to encourage investment in training, R&D, and university–industry collaboration in promoted sectors.

Source: Authors, from various sources.

8.4 | Future Directions for Innovation Policies in Thailand

To increase its growth rate, Thailand must raise its investment in R&D, produce more R&D personnel, and, most importantly, manage its R&D system better to achieve greater efficiency. We suggest that the government implements the following policies.

8.4.1 Increase public investment in R&D

To catch up with other East Asian countries, Thailand must invest significantly more in R&D. However, simply increasing its R&D investment will not guarantee greater innovation capability. Thailand must also invest wisely by allocating its limited public funds efficiently and using them to encourage private investment with the aim of creating a more demand-driven system. To achieve this, it will need to take the following actions.

- Increase the budget for basic research at least at the same rate as the nominal GDP growth rate while increasing the budget for applied R&D at a faster rate. The aim is to increase public investment in R&D to the 2% of GDP target in 2021 and to conduct relatively more applied R&D.
- Allocate most of the R&D budget through research-granting agencies that have good management records, rather than through agencies in line ministries that do not have research management capabilities. The aim is to increase the efficiency of public investment in R&D.
- Instruct granting agencies to allocate all basic research grants to universities through competitive funding. The only portion that should be exempted from competition is core funding for their basic functioning.
- Direct granting agencies to allocate funding for applied R&D towards matching funds from the private sector. For example, one baht of public money can be matched with one baht in funding from the private sector. The aim is to make universities and research institutes more responsive to the needs of the private sector and to encourage the private sector to invest more in R&D.

8.4.2 Create accountability in publicly funded research

Without an appropriate accountability mechanism, publicly funded research would not generate sufficient economic return. We suggest that the government hold publicly funded research accountable by setting clear targets:

- Set clear targets for research-granting agencies commensurate with the size of their funding. These agencies should be regularly evaluated by independent assessors to measure their impacts based on cost and benefit analyses. The results should be reported to cabinet, the parliament, and the public.
- Set clear targets for government research institutes that receive direct funding from the government commensurate with the size of their funding. They should also be evaluated similarly to the research-granting agencies mentioned above.

8.4.3 Create a specialised government research institute

We also suggest that the government create a specialised government research institute with the sole mission of conducting R&D for commercialisation. The institute can be modelled after the Industrial Technology Research Institute of Taiwan, A*Star of Singapore, the Fraunhofer Society of Germany, or other institutions with solid records. The new institute can be created either by spinning off the industrial technology unit of the NSTDA into an autonomous agency or by setting up a new entity from scratch. To ensure that the institute responds to market demands, its board of directors should be composed mainly of representatives from the private sector. In addition, it should be financed by matching funds between the public and private sectors in the manner mentioned above.

8.4.4 Improve human resources policies

A shortage of R&D human resources is a major bottleneck inhibiting the private sector from undertaking more R&D and innovation activities. To solve this problem, we suggest that the government improve its R&D human resources policies by:

- reforming the current government scholarship systems to be more demand driven by allowing private companies to contribute to scholarships in exchange for the right to hire scholarship recipients after graduation;
- allowing and encouraging R&D professionals in public universities and government research institutes to work in the private sector by expanding the Talent Mobility programme; and
- allowing foreign R&D personnel and highly skilled professionals to work in Thailand by abolishing the foreign national employment quotas and expediting immigration procedures.

8.5 | Conclusion and Summary of Policy Recommendations

Thailand's remarkable growth from the 1960s to the mid-1990s demonstrated its ability to transform itself from a traditional economy into a modern one based on manufacturing and services. The country has also shown it can diversify its exports, both in terms of products and market destinations. However, despite its past accomplishments, it has experienced lower growth rates since the 1997 Asian financial crisis. If it does not upgrade its R&D and innovation capabilities, the country risks falling into the middle-income trap. To achieve higher growth rates, Thailand needs to increase its investment in R&D, produce more R&D personnel, and, most importantly, manage its R&D system better to achieve greater efficiency. We suggest that the government improves the Thai R&D system by:

- increasing public investment in R&D and using public money to encourage private investment in R&D;
- creating accountability in publicly funded research by setting clear targets for research-granting agencies and government research institutes commensurate with the size of their funding, and evaluating these agencies regularly to measure their impacts;
- creating a specialised government research institute with the sole mission of conducting R&D for commercialisation and ensuring that it responds to market demands by designing appropriate governance and funding structures;
- improving R&D human resources policies by reforming the current government scholarship systems to be more demand driven, expanding the current Talent Mobility programme, and making it easier to employ foreign R&D personnel and highly skilled professionals; and
- making technology transfer an explicit objective of government procurement for the government's megaprojects, such as railway and water-management projects.

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